# Demonstration of Electrochemical Remediation Technology

## Technology Need:

Numerous DOE sites, such as the Y-12 National Security Complex in Oak Ridge, Tennessee, have soil and sediments contaminated with mercury, heavy metals, and radionuclides. Cost effective, *in situ* treatment technologies are needed to remove or stabilize this contamination. The baseline method at Y-12 for remediation of soils contaminated with mercury, radionuclides, and heavy metals is excavation, low temperature thermal desorption for mercury removal, followed by landfill disposal. Low temperature thermal desorption is relatively expensive, at an estimated cost of $740/cu. yd. Also, this technology does not treat non-volatile metals or radionuclides and it is primarily an ex situ technology. Ex situ treatment of soil containing free-liquid mercury poses many handling challenges including containment of liquid mercury beads and control of mercury vapors.

## Technology Description:

Electro-Chemical Remediation Technology (ECRT) is a proprietary remediation technology developed by Boden- und Grundwassersanierung, GmbH., Stuttgart, Germany. The technology is exclusively licensed to Weiss Associates (WA), a member of the TPG Applied Technology team, for application of the technology in North America.

ECRT uses local electrical power and proprietary direct current/alternating current (DC/AC) converters, to produce a low voltage and low amperage DC/AC signal, which is imposed through electrodes installed in soil and/or groundwater. ECRT is distinguished from traditional electrokinetic remediation by (1) operative mechanisms, (2) energy input required to perform remediation, (3) nature of the direct current field passing between the installed electrodes, and (4) resulting outcome. ECRT utilizes two principal processes for remediation: ElectroChemical GeoOxidation (ECGO), which is used to mineralize organic contaminants to their inorganic components (e.g. carbon dioxide and water), and Induced Complexation (IC), which significantly enhances the mobilization of metals and those radionuclides that behave as metals. This project will take advantage of IC for the removal of mercury, other metals, and radionuclides from soil.

The proprietary DC/AC potential is applied to electrodes, placed 10 to 15m apart in the soil. The electrodes can be pipe or sheet piling driven into the ground using pneumatic hammers or inserted into holes drilled into the earth. Mercury is driven to the energized electrodes, which are subsequently withdrawn from the soil, taking the mercury with them. This concept was tested on the bench-scale during this project. The bench-scale test set up is pictured in Figure 1.

Figure 1. Bench-scale ECRT test cell.

Mercury is removed from the contaminated electrodes by an electrochemical wash. The wash water is next treated with a patented process (ADA Technologies, Littleton, CO) to stabilize the mercury in a solid form that passes the TCLP mercury standard of 0.2 mg/L. The resulting solids can be disposed as nonhazardous waste.

## Benefits

- Mercury, metal, and radionuclide contamination is actually removed from the soil in an *in situ* process
- The process is rapid; remediation time is typically 6-12 months.
- The process is cost effective; projected cost range is $35-$134/cy.
- The process has potential for remediation of soils below buildings without excavation.

## Status and Accomplishments:

This project was initiated in October, 2001, and has progressed through completion of Phase I bench-scale testing. The projects includes an optional Phase II that consists of field-scale demonstration of the technology. In Phase I, ECRT was tested on a bench-scale using mercury-contaminated soil from Oak Ridge's Y-12 site. The test soil, collected from the basement of the Alpha-2 Building was a low permeability, high-clay soil. An ECRT test cell that contained approximately 150 liters of soil was operated for 741 hours. Post-test sampling indicated that mercury was transported out of the soil toward both electrodes. The initial mercury concentration was approximately 250 mg/kg and in some portions of the soil, this concentration was reduced to below 100 mg/kg after application of ECRT. The target TCLP level of 0.25 mg/l was also achieved in some portions of the soil. The technology developer believed that if the test were operated for a longer duration, that mercury would be removed from the entire volume of soil to the target TCLP levels.

ECRT has a successful track record of use in Europe and has been deployed over 50 times in various configurations. *In situ* ECRT IC, which is the focus of this project, has been deployed at two sites. At the Union Canal site in Scotland, approximately 400 mT of soil with an initial total mercury concentration of 1,570 mg/kg (average concentration: 243 mg/kg) was decontaminated to a final average total mercury concentration of 6 mg/kg within 26 days of ECRT IC operation. A total of 76 kg of mercury was plated onto the power electrodes (anodes and cathodes) during the remediation. A mass balance analysis based on the field data showed reasonably good agreement between the total mercury plated onto the electrodes and the pre- and post-remediation concentrations in the soil. A cross-sectional diagram of the electrode configuration used at the union canal site is provided in Figure 2. Note the circles to the right and left represent the cylindrical electrodes.

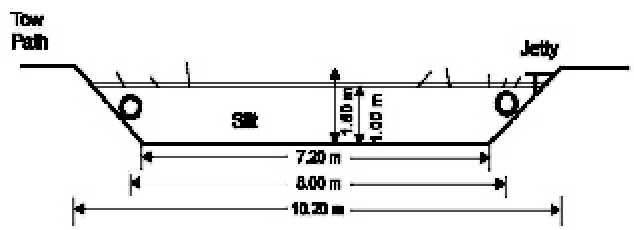


Figure 2. Cross sectional diagram of Union Canal ECRT set-up.

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## Online Resources:

Office of Science and Technology, Technology Management System (TMS), Tech ID # 3167
http://ost.em.doe.gov/tms

The National Energy Technology Laboratory Internet address is http://www.netl.doe.gov